no. 22

NOAA Technical Memorandum

NMFS-SEFC-22

AN EVALUATION OF MARKS ON HARDPARTS FOR AGE DETERMINATION OF ATLANTIC CROAKER, SPOT, SAND SEATROUT, AND SILVER SEATROUT

Lyman E. Barger

Allyn G. Johnson

U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary
National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator
National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator for Fisheries

This TM series is used for documentation and timely communication of preliminary results, interim reports, or similar special purpose information. Although the memos are not subject to complete formal review, editorial control, or detailed editing, they are expected to reflect sound professional work.

009977

Property of
NOAA Miami Library
4301 Rickenbacker Causeway
Florida 33149

ABSTRACT

An evaluation of marks on scales, vertebrae, and otoliths for age determination of Atlantic croaker, spot, sand seatrout, and silver seatrout was performed. Otoliths showed the most potential for accurate age determination of these species. Otolith radii and marks had high positive correlations with fish total lengths in all four species. Reasonable agreement was found between lengths at capture and backcalculated lengths based on otoliths for all four sciaenids.

INTRODUCTION

This study was undertaken to examine and compare the markings on scales, vertebrae, and otoliths (sagittae) for age determination of four sciaenids: Atlantic croaker (Micropogonias undulatus)[1], spot (Leiostomus xanthurus), sand seatrout (Cynoscion arenarius), and silver seatrout (C. nothus). These fish are four of the six species that predominate the northcentral Gulf of Mexico groundfish fishery.

Age determination using scales or otoliths has been done or attempted by others on three of the four species, but no one has compared scales, otoliths, and vertebrae in each species to determine the best structure for age determination. Atlantic croaker was studied using scales by White and Chittenden (1977). Age determination of spot was done with scales by Walsh and Breder (1928), Sundararaj (1960), and Pacheco (1962) and otoliths by Sundararaj (1960). Benefield (1970) attempted unsuccessfully to use scales to determine the age of sand seatrout.

MATERIALS METHODS

Most of the fish used in this study were taken in the northcentral Gulf of Mexico by personnel of the National Marine Fisheries Service (NMFS) laboratory at Pascagoula, Mississippi; additional samples of Atlantic croaker were taken from St. Andrew Bay, Florida during May 1979 by personnel of the NMFS laboratory at Panama City, Florida. All fish were frozen prior to processing. After thawing, the total length of each fish was measured to the nearest millimeter, and the hardparts (scales, vertebrae, and otoliths) were then removed and stored. Scales were removed from the left side of the fish under the distal edge of the pectoral fin, dried, and stored. In some cases, especially in the seatrouts, scales had to be obtained from elsewhere on the sides of the body. Scales were cleaned in a solution of detergent and water, mounted between two glass slides, and read on an Eberbach[2] projector at 40X.

Otoliths were removed, wiped clean, dried, and stored prior to preparation for reading. Otoliths, with the exception of those from spot, were too thick to be read whole and thus were sectioned. Cross sections were cut (0.18 mm thick) from the otolith with a low speed Isomet saw. The sections were cut through, or as close as possible to, the focus. The sections were mounted on glass slides with Piccolyte cement and were viewed on an Eberbach projector at 40X. Measurements were made from the focus radially along a line formed by the edge of the sulcus acousticus. This line is almost perpendicular to the proximal surface of the otolith when the cross section is made through the focus. The measurements consisted of the distances from the focus to the distal edge of marks, and the focus to the proximal surface of the otolith (Figure 1).

---

[1]The genus Micropogon was found to be preoccupied by a genus of Aves by Chao (1978); thus Micropoganias has been substituted.

[2]Reference to trade names does not constitute endorsement by the National Marine Fisheries Service, NOAA.

Otoliths from spot were placed on a black dish containing glycerin, read, and measured under reflected light with the aid of a dissecting binocular microscope at 10X magnification. The measurements consisted of the distance from the focus to the anterior edge of the otolith and from the focus to the distal edge of each mark (Figure 2).

The ninth and tenth vertebrae anterior to the hypural plate were removed, cleaned of excess flesh, immersed in 0.01% crystal violet for 6 to 18 hours and then air dried. Dry vertebrae were cut in half along the frontal plane with a Dremal saw. Vertebral centra were viewed with a dissecting microscope.

Growth marks on the hardparts were read independently by two readers using the following criteria:

Scales - one growth cycle was assumed to be represented by a zone of widely spaced circuli (light band) followed by a zone of closely spaced circuli (dark band). Dark bands in some instances contained crossovers, which aided in their identification (Figure 3).

Otoliths - one growth cycle was assumed to be represented by a hyaline zone (with transmitted light, zone appears light; under reflected light, zone appears dark) plus the following opaque zone (with transmitted light, zone appears dark; under reflected light, zone appears light). The end of the growth cycle was the distal edge of the opaque zone.

Vertebrae - one growth cycle was assumed to be represented by a prominent concentric ridge and its preceding groove on the centrum (Figure 4).

Agreement of 80% or greater between the two readers was considered acceptable. Eighty to ninety percent agreement on the age of short-lived fish was considered acceptable by Ricker (1975).

The relationship between fish total length and (1) otolith radius and (2) number of otolith opaque marks were determined by least square methods. A computer program was used to determine the best fit of the data to one of six curves - linear, power, three hyperbolics, and an exponential.

Backcalculations of length at age were computed on the assumption that the opaque marks on the otoliths were annuli. These backcalculated values were compared to our empirical values and also to backcalculated values reported in the literature.

RESULTS AND DISCUSSION

The percentage agreement between the independent readings of the three hardparts varied. Agreement on otoliths was the highest; it was greater than 85% on each of the four species. The readers were in agreement on less than 80% of the scales and on less than 70% of the vertebrae (Table 1).

White and Chittenden (1977) presented evidence for use of scale marks as valid indicators of age for Atlantic croaker. The marks on the scales of our Atlantic croaker were not as well defined as those illustrated in their paper, thus the low agreement between our readings.

Sundararaj (1960) and Pacheco (1962) presented evidence for validation of scales as an age determination method for spot, but Walsh and Breder (1924) found that the determination of the age of spot by scale examination was difficult due to faintness of the rings. Our collection of spot scales did not have distinctive marks, therefore, we were unable to obtain a satisfactory level of agreement between readings.

Sundararaj (1960) also presented evidence for otoliths as a valid age determination structure for spot. Both his and our otoliths had the same appearance, and marks were easily counted and measured. We had difficulty in determining what Sundararaj considered the annulus, as his written description and illustrations (his Figures 9-12) did not agree. Depending on which band (translucent or opaque) was counted and what radial measurement was made the counts and measurements would influence the estimated age and the backcalculated length at time of mark formation.

Of the hardparts the otoliths possessed the highest potential as age determination structures. Reasonably strong correlations were obtained between fish total length and otolith radius (Figure 5). The silver seatrout had the lowest correlation, which may have resulted from the limited length (65 mm between minimum and maximum). Positive relations existed between the number of marks on the otoliths and fish total lengths in all four species (Figure 6).

Backcalculated fish total lengths at time of mark formation and the mean length at capture were in reasonable agreement, taking into account the growth between formation of the last mark and the time of capture (Table 2). Large numbers of Age 0 fish, small age spread, and small numbers of older fish occurred in our collections; these conditions influenced the backcalculated data. Empirical data for sand seatrout showed lower length for Age 2 than for Age 1 which was probably due to one of the above defects in our sample. Comparison with other studies show general agreement for backcalculated lengths of Atlantic croaker and spot at Age 1, whereas greater differences were obtained for Age 2 (Table 3).

CONCLUSION

Of the three hardparts, otoliths were the best for age determination in all species. Good agreement between readers indicated accurate enumeration of marks.

Our study showed that positive relations existed between fish total length and (1) the otolith radius and (2) number of otolith marks. Good agreement occurred between backcalculated fish lengths and lengths at capture for each age class.

LITERATURE CITED

BENEFIELD, R.L. 1970. A study of sand seatrout (Cynoscion arenarius Ginsburg) of the Galveston Bay area. Texas Parks and Wildl. Dept. Coastal Fisheries Project Reports 1969-1970, 217-225.

CHAO, L.N. 1978. A basis for classifying western Atlantic Sciaenidae (Teleostei: Perciformes). U.S.D.C., NOAA, Tech. Rep. NMFS Circ. 415. 64 p.

PACHECO, A.L. 1962. Age and growth of spot in lower Chesapeake Bay, with notes on distribution and abundance of juveniles in York River system. Chesapeake Sci. 3(1):18-28.

RICKER, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Canada. No. 191, 382 p.

SUNDARARAJ, B.I. 1960. Age and growth of spot, Leiostomus xanthurus Lacépède. Tulane Stud. Zool. 8(2):41-62.

WELSH, W.W., and C.M. BREDER, Jr. 1924. Contributions to life histories of Sciaenidae of the eastern U.S. coast. Bull. U.S. Bur. Fish. 39:141-201.

WHITE, M.L., and M.E. CHITTENDEN, Jr. 1977. Age determination, reproduction, and population dynamics of the Atlantic croaker, Micropogon undulatus. Fish. Bull. 75(1):109-123.

Table 1. Percent agreement between readers on the number of marks on hardparts of four sciaenids. The number of samples is in parenthesis.

Species	Hardparts					
	Scale		Vertebrae		Otoliths	
Atlantic croaker	57	(79)	65	(93)	87	(92)
Spot	70	(101)	58	(71)	98	(100)
Sand seatrout	77	(100)	51	(67)	94	(97)
Silver seatrout	40	(92)	42	(67)	92	(88)

Table 2. Mean backcalculated total lengths (TL in millimeters) at marks on otoliths for four sciaenids.

Assumed Age Group	Number of Fish	Number of Marks 1	2	3	4	5
		Atlantic croaker				
1	22	184.0				
2	23	159.9	230.8			
3	8	163.3	218.5	276.4		
4	5	160.9	216.3	262.4	311.8	
5	3	155.7	203.7	256.4	293.9	337.1
Mean TL at age	61	168.9	224.4	268.3	305.1	337.1
Mean TL at capture	61	238.1	277.5	294.0	332.6	349.0
		Spot				
1	50	154.8				
2	3	143.4	189.2			
Mean TL at age	53	154.1	189.2			
Mean TL at capture	53	196.5	215.7			
		Sand seatrout				
1	35	212.1				
2	13	168.9	247.5			
Mean TL at age	48	200.4	247.5			
Mean TL at capture	48	307.6	296.4			
		Silver seatrout				
1	10	170.9				
2	10	153.9	211.6			
3	1	107.8	163.3	215.6		
Mean TL at age	21	159.8	207.2	215.6		
Mean TL at capture	21	209.7	232.7	245.0		

Table 3. Comparison of backcalculated total lengths (mm) of Atlantic croaker and spot determined by us and others.

Species and Study	Structure used	Age 1	2	3	4	5
Atlantic croaker						
Present	Otolith	169	224	269	305	337
White and Chittenden (1977)	Scale	165	270			
Spot						
Present	Otolith	154	189			
Sundararaj (1960)	Otolith	153	212	225		

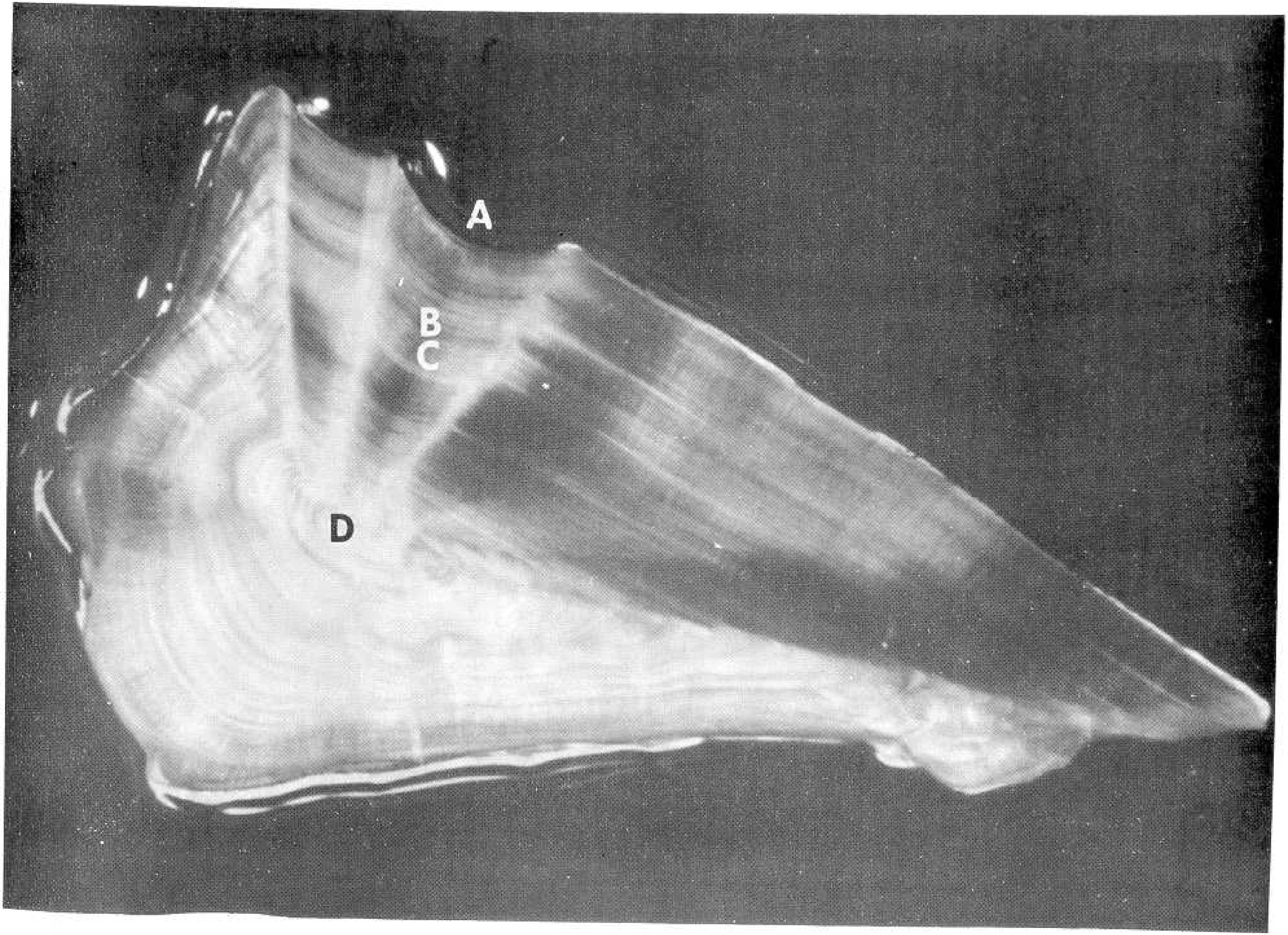

Figure 1. Cross section of an Atlantic croaker otolith under reflected light (A - proximal margin, B - hyaline zone, C - opaque zone, and D - focus)

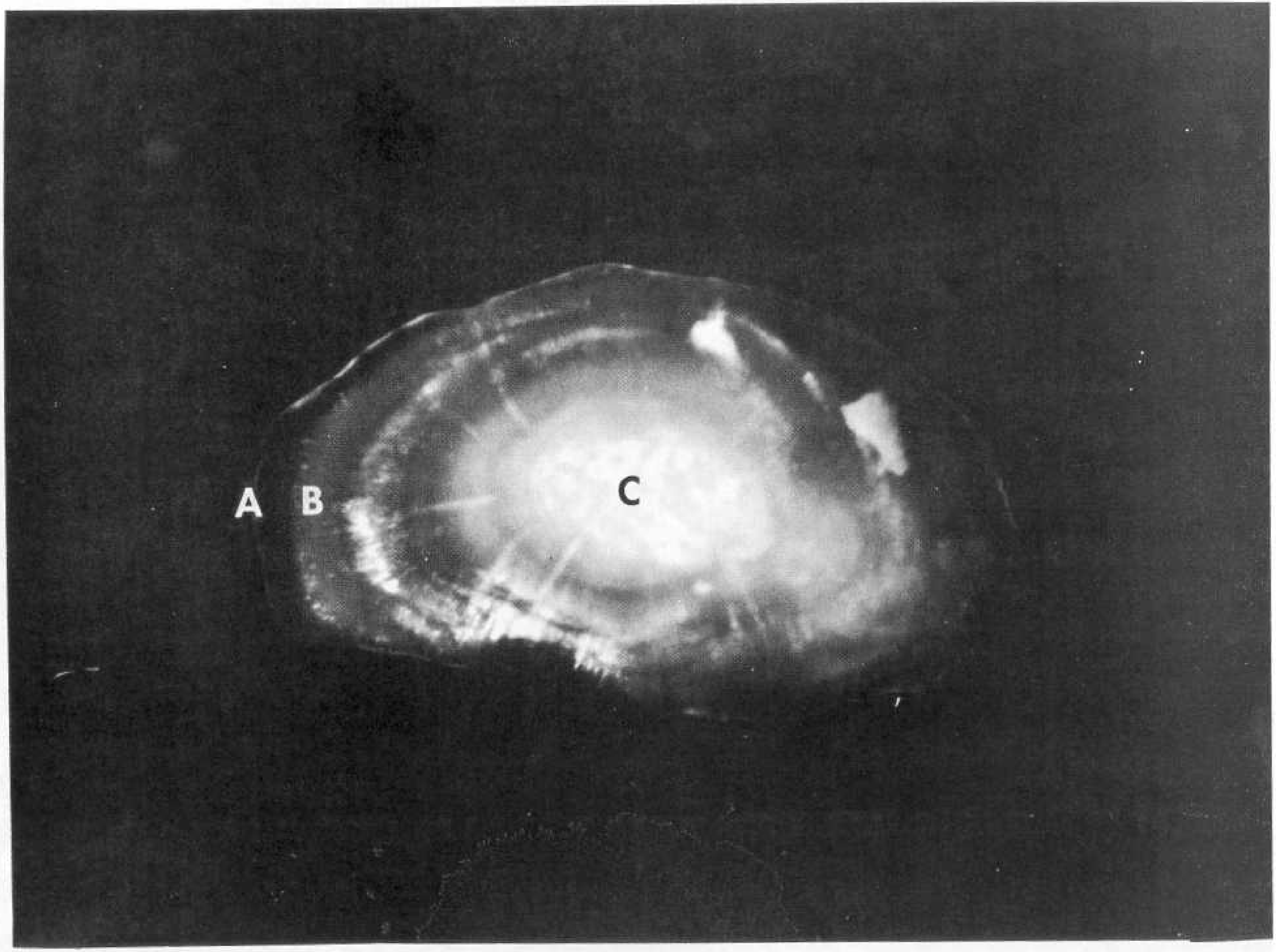

Figure 2. Whole otolith of a spot under reflected light (A - anterior edge, B - opaque zone, and C - focus).

Figure 3. Atlantic croaker scale (A - light band and B - dark band).

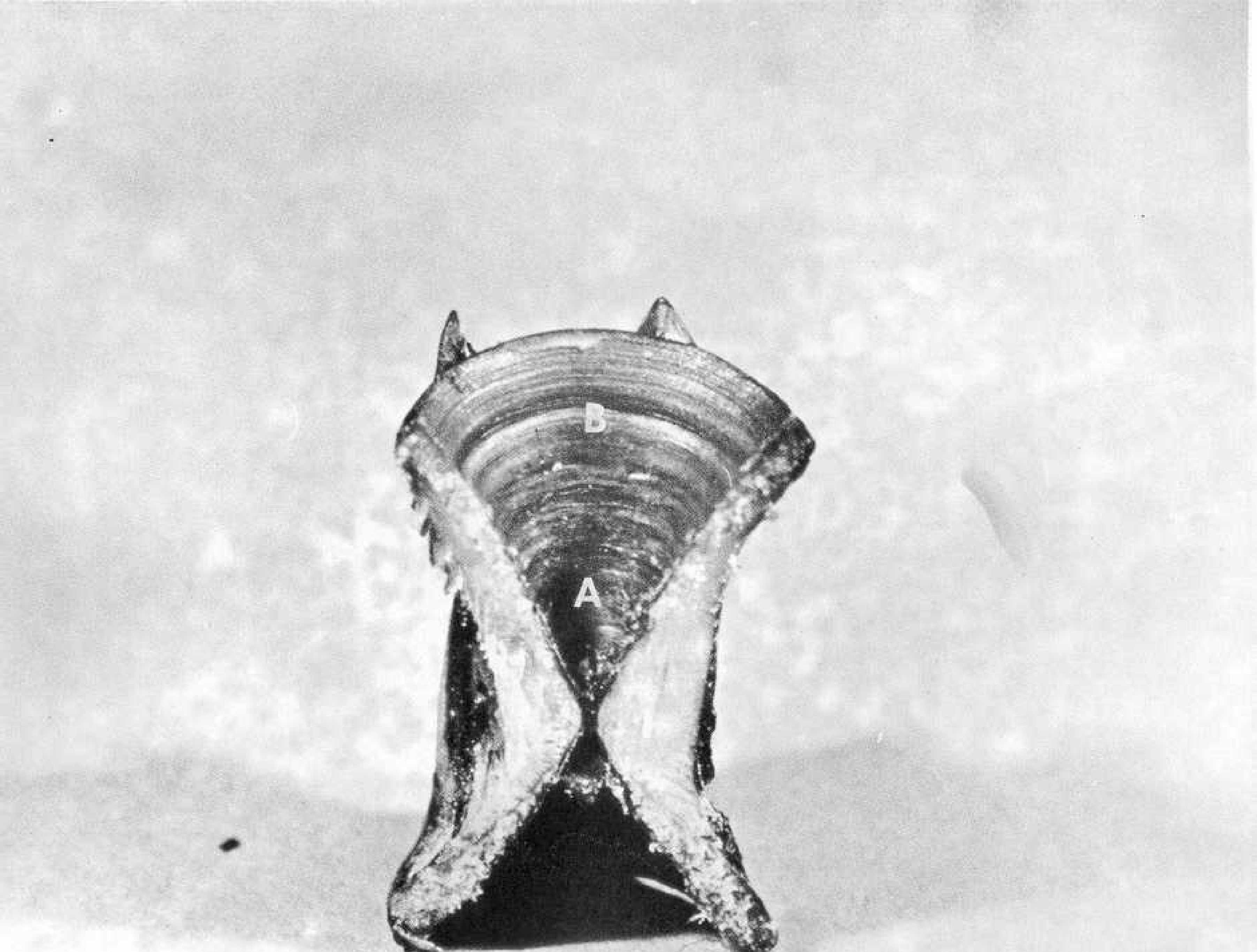

Figure 4. Atlantic croaker vertebral centrum (A - groove and B - ridge).

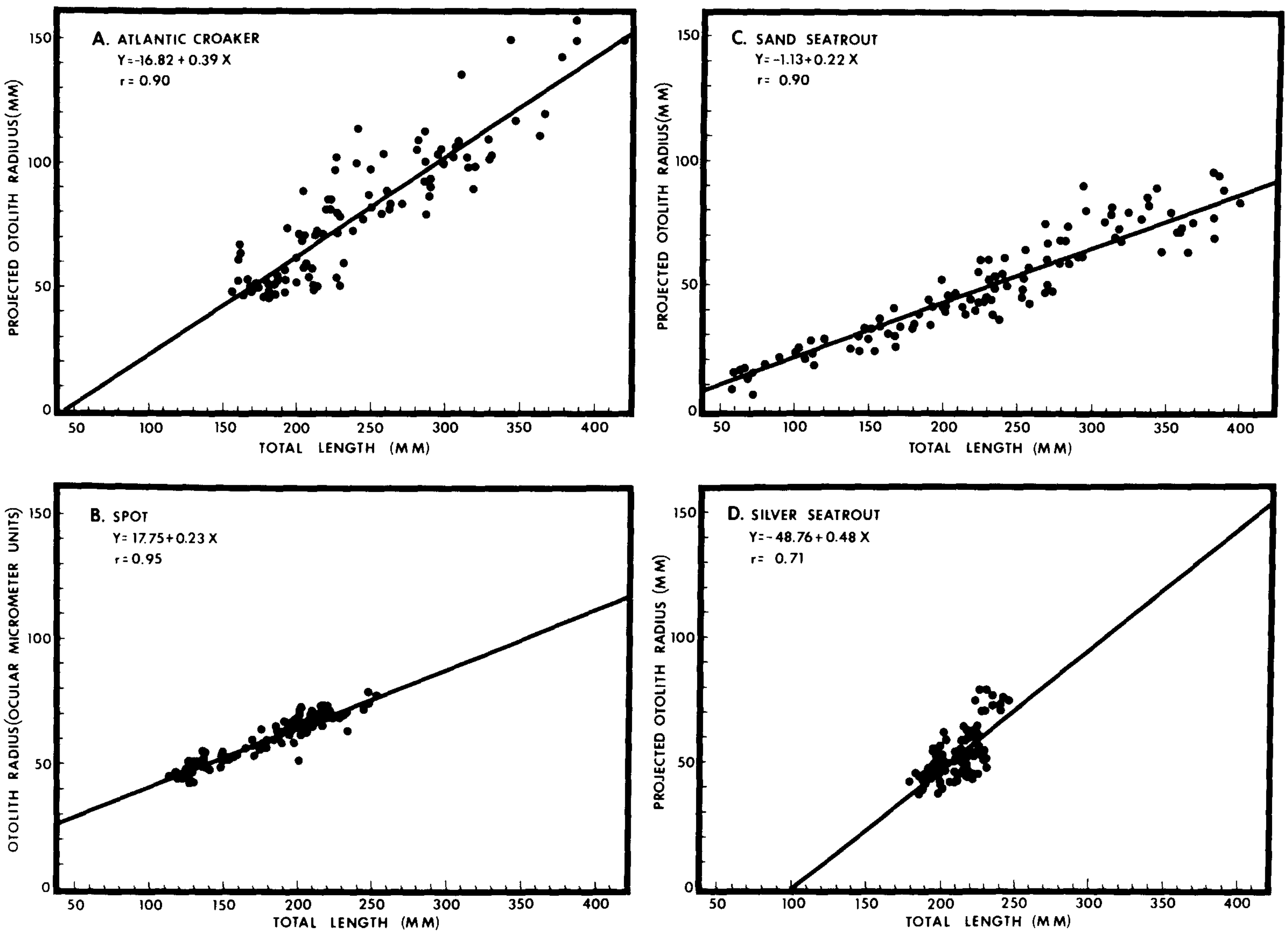

Figure 5. Relationship of total length (in millimeters) and otolith radius (in millimeters) of (A) Atlantic croaker, (B) spot, (C) sand seatrout, and (D) silver seatrout.

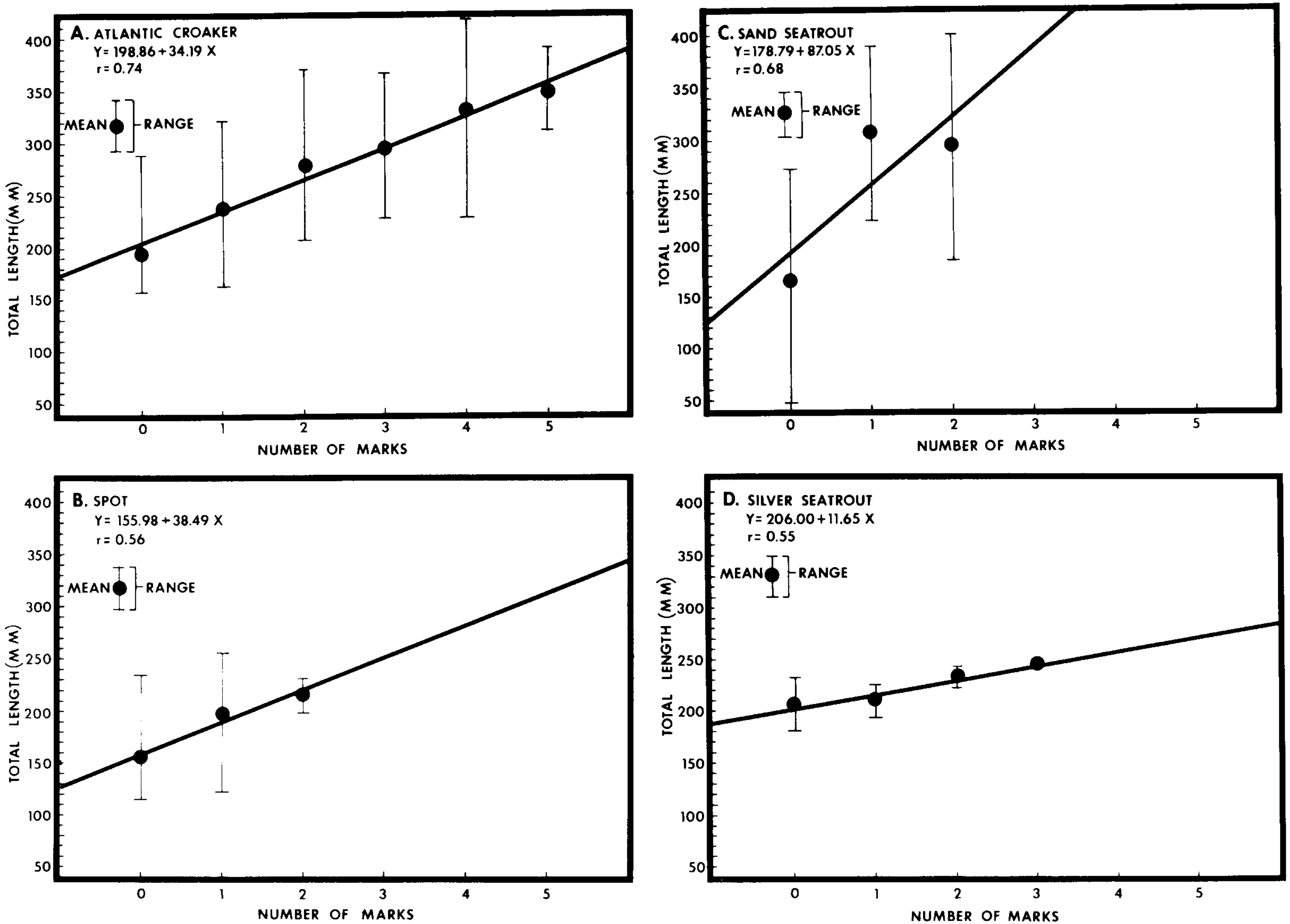

Figure 6. Relationship of number of otolith marks and total length (in millimeters) of (A) Atlantic croaker, (B) spot, (C) sand seatrout, and (D) silver seatrout.